

# 基于数学软件（Mathematica、Matlab 等）的 LaTeX 源程序生成

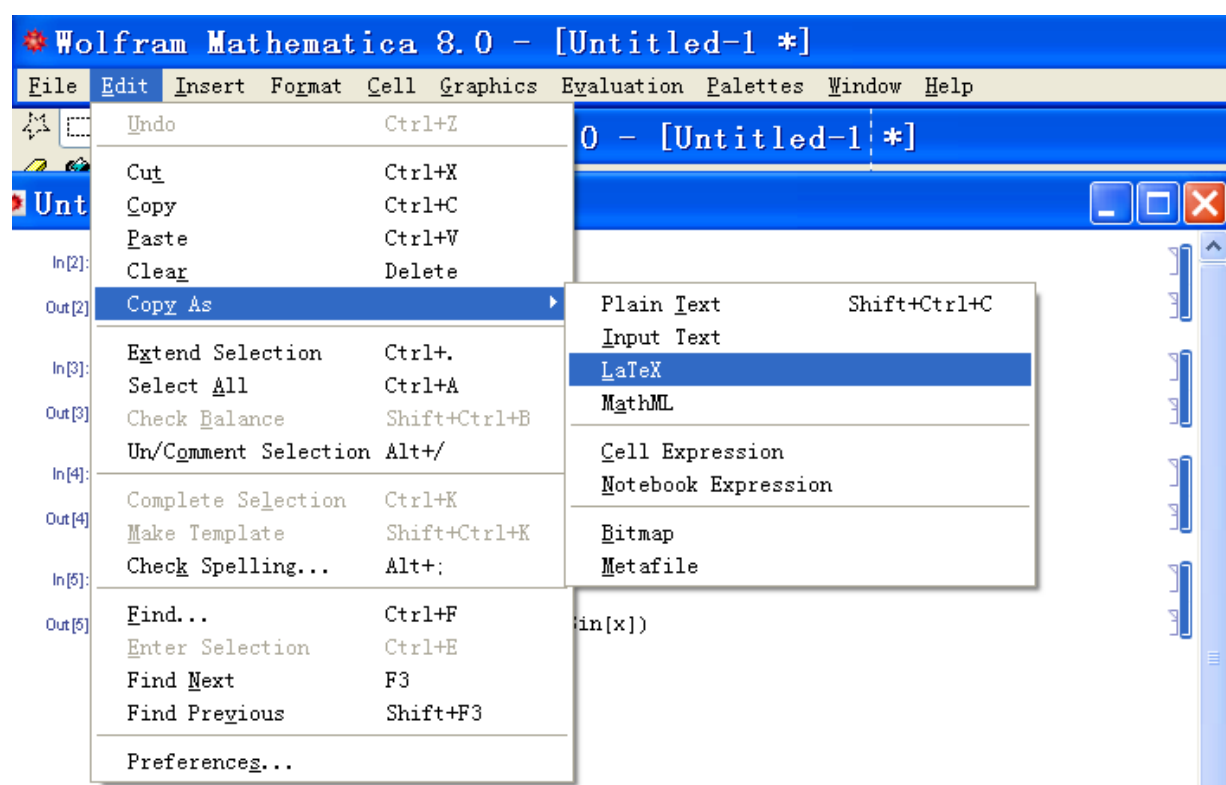
本讲要点：

- 一、Mathematica 与 LaTeX 源程序
- 二、Matlab 与 LaTeX 源程序
- 三、练习

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## 一、Mathematica 与 LaTeX 源程序

Mathematica 软件直接基于符号运算，因此，可以利用它直接得到有关的 LaTeX 源程序。方法是：



例 1（简单应用）：已知  $f(x) = \sin^5(x)$ ，求  $f'''(x)$ 。

`D[Sin[x]^5,{x,3}]`

结果为： $60 \cos^3(x) \sin^2(x) - 65 \cos(x) \sin^4(x)$

选中上述细胞（cell），然后 **Copy As LaTeX** 格式，得到 LaTeX 源程序为：

`D[\text{Sin}[x]^{\wedge}5,\{x,3\}]`

60 \text{Cos}[x]^3 \text{Sin}[x]^2-65 \text{Cos}[x] \text{Sin}[x]^4

**例 2（较复杂应用）：** 已知  $f(x) = (\sin x)^{\cos x}$ ，求  $f''(x)$ 。

D[(Sin[x])^Cos[x],{x,2}]

结果为：  $(-2 \cos[x] - \cot[x] \csc[x] - \cos[x] \log[\sin[x]]) \sin[x]^{\cos[x]} + \sin[x]^{\cos[x]} (\cos[x] \cot[x] - \log[\sin[x]] \sin[x])^2$

选中上述细胞（cell），然后 **Copy As LaTeX 格式**，得到 **LaTeX** 源程序为：

D[(\text{Sin}[x])^{\wedge}\text{Cos}[x],\{x,2\}]

$$(-2 \cos[x] - \cot[x] \csc[x] - \cos[x] \log[\sin[x]]) \sin[x]^{\cos[x]} + \sin[x]^{\cos[x]} (\cos[x] \cot[x] - \log[\sin[x]] \sin[x])^2$$

也可使用自定义函数：

**例3（较复杂应用）：** 已知  $f(x, y) = (\sin x)^{\cos y}$ ，求  $\frac{\partial^3 f(x, y)}{\partial x^2 \partial y}$ 。

myfun[x\_,y\_]:=Sin[x]^Cos[y]

D[myfun[x,y],{x,2},{y,1}]

结果为：

$$-\cos[x]^2 (-1 + \cos[y]) \sin[x]^{-2 + \cos[y]} \sin[y] - \cos[x]^2 \cos[y] \sin[x]^{-2 + \cos[y]} \sin[y] - \cos[x]^2 (-1 + \cos[y]) \cos[y] \log[\sin[x]] \sin[x]^{-2 + \cos[y]} \sin[y] + \sin[x]^{\cos[y]} \sin[y] + \cos[y] \log[\sin[x]] \sin[x]^{\cos[y]} \sin[y]$$

选中上述细胞（cell），然后 **Copy As LaTeX 格式**，得到 **LaTeX** 源程序为：

\text{myfun}[\text{x}\\_\\$, \text{y}\\_\\$]\text{:=}\text{Sin}[x]^{\wedge}\text{Cos}[y]

D[\text{myfun}[x,y],\{x,2\},\{y,1\}]

$$-\cos[x]^2 (-1 + \cos[y]) \sin[x]^{-2 + \cos[y]} \sin[y] - \cos[x]^2 \cos[y] \sin[x]^{-2 + \cos[y]} \sin[y] - \cos[x]^2 (-1 + \cos[y]) \cos[y] \log[\sin[x]] \sin[x]^{-2 + \cos[y]} \sin[y] + \sin[x]^{\cos[y]} \sin[y] + \cos[y] \log[\sin[x]] \sin[x]^{\cos[y]} \sin[y]$$

**例 4（复杂应用）：** 已知  $f(x) = x^{x^{x^x}}$ ，求  $f'''(x)$ 。

(1) Mathematica 命令：

D[x^x^x^x,{x,3}] （或 D[x^(x^(x^x)),{x,3}]）

(2) Mathematica 结果：

$$x^{x^{x^x}} (x^{-1+x^x} + x^{x^x} \log[x] (x^{(-1+x)} + x^x \log[x] (1 + \log[x])))^3 + 3 x^{x^{x^x}} (x^{-1+x^x} + x^{x^x} \log[x] (x^{-1+x} + x^x \log[x] (1 + \log[x]))) (x^{-1+x^x} (x^{-1+x} + x^x \log[x] (1 + \log[x])) + x^{x^x} \log[x] (x^{(-1+x)} + x^x \log[x] (1 + \log[x])))^2 + x^{-1+x^x} ((-1+x^x)/x + x^x \log[x] (1 + \log[x])) + x^{x^x} \log[x] (x^{-1+x} + x^x \log[x] (1 + \log[x]))^2 + x^{-1+x} ((-1+x)/x + \log[x])) + x^{x^{x^x}} (x^{-1+x^x} (x^{(-1+x)} + x^x \log[x] (1 + \log[x])))^2 + x^{x^x} \log[x]$$

$$\begin{aligned}
& (x^{(-1+x)} + x^x \log[x] (1 + \log[x]))^3 + x^{-1+x^x} (x^{-1+x+xx} \log[x] (1 + \log[x])) \\
& ((-1+xx)/x + xx \log[x] (1 + \log[x])) + x^{-1+x^x} ((-1+x^x)/x + x^x \log[x] (1 + \log[x]))^2 + x^{-1+x^x} \\
& (-((-1+xx)/x^2) + x^{-1+x} \log[x] + 2 x^{-1+x} (1 + \log[x]) + xx \log[x] (1 + \log[x])^2) + 2 x^{-1+x^x} \\
& (x^{-1+x} \log[x] + x^{-1+x} (1 + \log[x]) + xx \log[x] (1 + \log[x])^2 + x^{-1+x} ((-1+x)/x + \log[x])) + 3 \\
& x^x \log[x] (x^{-1+x+xx} \log[x] (1 + \log[x])) (x^{-1+x} \log[x] + x^{-1+x} (1 + \log[x]) + xx \log[x] \\
& (1 + \log[x])^2 + x^{-1+x} ((-1+x)/x + \log[x])) + x^x \log[x] (2 x^{-2+x} + (-((-1+x)/x^2) + 2/x) \\
& x^{-1+x+2} x^{-1+x} \log[x] (1 + \log[x]) + x^{-1+x} (1 + \log[x])^2 + xx \log[x] (1 + \log[x])^3 + x^{-1+x} \\
& \log[x] ((-1+x)/x + \log[x]) + x^{-1+x} (1 + \log[x]) ((-1+x)/x + \log[x]) + x^{-1+x} \\
& ((-1+x)/x + \log[x])^2)
\end{aligned}$$

(3) LaTeX 命令 1 (原始程序) :

$$\begin{aligned}
& x^{x^{x^x}} \left( x^{-1+x^x} + x^{x^x} \log[x] \left( x^{-1+x} + x^x \log[x] (1 + \log[x]) \right) \right)^3 + x^{x^{x^x}} \\
& \left( x^{-1+x^x} + x^{x^x} \log[x] \left( x^{-1+x} + x^x \log[x] (1 + \log[x]) \right) \right)^2 + x^{x^{x^x}} \\
& \left( x^{-1+x^x} + x^{x^x} \log[x] (1 + \log[x]) \right) + x^{x^x} \log[x] (1 + \log[x])^2 + x^{x^{x^x}} \\
& \left( x^{-1+x} \log[x] + x^{-1+x} (1 + \log[x]) + xx \log[x] (1 + \log[x])^2 + x^{-1+x} \left( \frac{-1+x}{x} + \log[x] \right) \right) + 3 \\
& x^x \log[x] (x^{-1+x+xx} \log[x] (1 + \log[x])) (x^{-1+x} \log[x] + x^{-1+x} (1 + \log[x]) + xx \log[x] \\
& (1 + \log[x])^2 + x^{-1+x} \left( \frac{-1+x}{x} + \log[x] \right)) + x^x \log[x] (2 x^{-2+x} + (-((-1+x)/x^2) + 2/x) \\
& x^{-1+x+2} x^{-1+x} \log[x] (1 + \log[x]) + x^{-1+x} (1 + \log[x])^2 + xx \log[x] (1 + \log[x])^3 + x^{-1+x} \\
& \log[x] \left( \frac{-1+x}{x} + \log[x] \right) + x^{-1+x} (1 + \log[x]) \left( \frac{-1+x}{x} + \log[x] \right) + x^{-1+x} \\
& \left( \frac{-1+x}{x} + \log[x] \right)^2)
\end{aligned}$$

(4) LaTeX 命令 2 (经过加工后的程序) :

\$\$



$$\begin{aligned}
& x^{x^{x^x}} \left( x^{-1+x^x} + x^{x^x} \ln(x) \left( x^{-1+x} + x^x \ln(x)(1 + \ln(x)) \right) \right)^3 + \\
& 3x^{x^{x^x}} \left( x^{-1+x^x} + x^{x^x} \ln(x) \left( x^{-1+x} + x^x \ln(x)(1 + \ln(x)) \right) \right) \\
& \left( x^{-1+x^x} \left( x^{-1+x} + x^x \ln(x)(1 + \ln(x)) \right) + x^{x^x} \ln(x) \left( x^{-1+x} + x^x \ln(x)(1 + \ln(x)) \right) \right)^2 + \\
& x^{-1+x^x} \left( \frac{-1+x^x}{x} + x^x \ln(x)(1 + \ln(x)) \right) + \\
& x^{x^x} \ln(x) \left( x^{-1+x} \ln(x) + x^{-1+x}(1 + \ln(x)) + x^x \ln(x)(1 + \ln(x))^2 + \right. \\
& \left. x^{-1+x} \left( \frac{-1+x}{x} + \ln(x) \right) \right) + \\
& x^{x^{x^x}} \left( x^{-1+x^x} \left( x^{-1+x} + x^x \ln(x)(1 + \ln(x)) \right)^2 + x^{x^x} \ln(x) \left( x^{-1+x} + x^x \ln(x)(1 + \ln(x)) \right)^3 + \right. \\
& \left. x^{-1+x^x} \left( x^{-1+x} + x^x \ln(x)(1 + \ln(x)) \right) \left( \frac{-1+x^x}{x} + x^x \ln(x)(1 + \ln(x)) \right) + \right. \\
& \left. x^{-1+x^x} \left( \frac{-1+x^x}{x} + x^x \ln(x)(1 + \ln(x)) \right)^2 + \right. \\
& \left. x^{-1+x^x} \left( -\frac{-1+x^x}{x^2} + x^{-1+x} \ln(x) + 2x^{-1+x}(1 + \ln(x)) + x^x \ln(x)(1 + \ln(x))^2 \right) + \right. \\
& \left. 2x^{-1+x^x} \left( x^{-1+x} \ln(x) + x^{-1+x}(1 + \ln(x)) + x^x \ln(x)(1 + \ln(x))^2 + \right. \right. \\
& \left. \left. x^{-1+x} \left( \frac{-1+x}{x} + \ln(x) \right) \right) + 3x^{x^x} \ln(x) \left( x^{-1+x} + x^x \ln(x)(1 + \ln(x)) \right) \right. \\
& \left. \left( x^{-1+x} \ln(x) + x^{-1+x}(1 + \ln(x)) + x^x \ln(x)(1 + \ln(x))^2 + x^{-1+x} \left( \frac{-1+x}{x} + \ln(x) \right) \right) + \right. \\
& \left. x^{x^x} \ln(x) \left( 2x^{-2+x} + \left( -\frac{-1+x}{x^2} + \frac{2}{x} \right) x^{-1+x} + 2x^{-1+x} \ln(x)(1 + \ln(x)) + \right. \right. \\
& \left. \left. x^{-1+x}(1 + \ln(x))^2 + x^x \ln(x)(1 + \ln(x))^3 + x^{-1+x} \ln(x) \left( \frac{-1+x}{x} + \ln(x) \right) + \right. \right. \\
& \left. \left. x^{-1+x}(1 + \ln(x)) \left( \frac{-1+x}{x} + \ln(x) \right) + x^{-1+x} \left( \frac{-1+x}{x} + \ln(x) \right)^2 \right) \right)
\end{aligned}$$

## 二、Matlab 与 LaTeX 源程序

Matlab 软件也有符号运算功能，可以利用它得到有关的 LaTeX 源程序，方法是利用 Matlab 的转换函数 `latex (···)`。Matlab 给出的帮助文件如下：

```
>> help latex
--- help for sym/latex.m ---
```

LATEX LaTeX representation of a symbolic expression.

LATEX(S) returns the LaTeX representation of the symbolic expression S.

Examples:

```
syms x
f = taylor(log(1+x));
latex(f) =
x-1/2\, \{x\}^{\{2\}}+1/3\, \{x\}^{\{3\}}-1/4\, \{x\}^{\{4\}}+1/5\, \{x\}^{\{5\}}
```

```
H = sym(hilb(3));
latex(H) =
```

```
\left [\begin {array} {ccc} 1&1/2&1/3\\\noalign{\medskip}1/2&1/3&1/4\\\noalign{\medskip}1/3&1/4&1/5\end {array}\right ]
```

```
syms alpha t
A = [alpha t alpha*t];
latex(A) =
\left [\begin {array} {ccc} \alpha&t&\alpha\,t\end {array}\right ]
```

See also pretty, ccode, fortran.

**例 5 (简单应用):** 已知  $f(x) = \sin^5(x)$ , 求  $f'''(x)$ .

```
>> syms x
>> latex(diff(sin(x)^5, x, 3))
```

得到的 LaTeX 命令为:

```
60\, \left( \sin \left( x \right) \right) ^{2} \left( \cos \left( x \right) \right) ^{3}-65\, \left( \sin \left( x \right) \right) ^{4} \cos \left( x \right)
```

**例 6 (较复杂应用):** 已知  $f(x) = (\sin x)^{\cos x}$ , 求  $f''(x)$ .

```
>> syms x
>> latex(diff(sin(x)^cos(x), x, 2))
```

得到的 LaTeX 命令为:

```
\left( \sin \left( x \right) \right) ^{\cos \left( x \right) } \left( -\sin \left( x \right) \ln \left( \sin \left( x \right) \right) +{\frac {\left( \cos \left( x \right) \right) ^{2}}{\sin \left( x \right) }} \right) ^{2}+ \left( \sin \left( x \right) \right) ^{\cos \left( x \right) } \left( -\cos \left( x \right) \ln \left( \sin \left( x \right) \right) -3\, \cos \left( x \right) -{\frac {\left( \cos \left( x \right) \right) ^{3}}{\left( \sin \left( x \right) \right) ^{2}}} \right)
```

也可使用自定义函数:

**例7 (较复杂应用):** 已知  $f(x, y) = (\sin x)^{\cos y}$ , 求  $\frac{\partial^3 f(x, y)}{\partial x^2 \partial y}$ .

```
>> syms x y
>> myfun = sin(x)^cos(y);
>> result= diff(diff(myfun, x, 2), y)
>> latex(result)
```

Matlab 的结果为:

```
-sin(x)^cos(y)*sin(y)*log(sin(x))*cos(y)^2*cos(x)^2/sin(x)^2-2*sin(x)^cos(y)*cos(y)*cos(x)^2/sin(x)^2*sin(y)+sin(x)^cos(y)*sin(y)*log(sin(x))*cos(y)+sin(x)^cos(y)*sin(y)+sin(x)^cos(y)*sin(y)*log(sin(x))*cos(y)*cos(x)^2/sin(x)^2+
```

$$\sin(x) \cos(y) \sin(y) \cos(x)^2 / \sin(x)^2$$

得到的 LaTeX 命令为:

```
-\frac {\left( \sin \left( x \right) \right) ^{\cos \left( y \right) }\sin \left( y \right) \ln \left( \sin \left( x \right) \right) \left( \cos \left( y \right) \right) ^{2} \left( \cos \left( x \right) \right) ^{2}}{\left( \sin \left( x \right) \right) ^{2}}-2\, \frac {\left( \sin \left( x \right) \right) ^{\cos \left( y \right) }\cos \left( y \right) \left( \cos \left( x \right) \right) ^{2} \sin \left( y \right) }{\left( \sin \left( x \right) \right) ^{2}}+\left( \sin \left( x \right) \right) ^{\cos \left( y \right) }\sin \left( y \right) \ln \left( \sin \left( x \right) \right) \cos \left( y \right) +\left( \sin \left( x \right) \right) ^{\cos \left( y \right) }\sin \left( y \right) +\frac {\left( \sin \left( x \right) \right) ^{\cos \left( y \right) }\sin \left( y \right) \ln \left( \sin \left( x \right) \right) \cos \left( y \right) \left( \cos \left( x \right) \right) ^{2}}{\left( \sin \left( x \right) \right) ^{2}}+\frac {\left( \sin \left( x \right) \right) ^{\cos \left( y \right) }\sin \left( y \right) \left( \cos \left( x \right) \right) ^{2}}{\left( \sin \left( x \right) \right) ^{2}}
```

**例8 (复杂应用):** 已知  $f(x) = x^{x^x}$ , 求  $f'''(x)$ .

(1) Matlab 命令: (注意不可写成: `diff(x^x^x,x,3)`, 为什么?)  
`diff(x^(x^(x^x)),x,3)`

(2) Matlab 结果:

```
x^(x^(x^x))*(x^(x^x)*(x^x*(log(x)+1)*log(x)+x^x/x)*log(x)+x^(x^x)/x)^3+3*x^(x^(x^x))*(x^(x^x)*(x^x*(log(x)+1)*log(x)+x^x/x)*log(x)+x^(x^x)/x)*(x^(x^x)*(x^x*(log(x)+1)*log(x)+x^x/x)^2*log(x)+x^(x^x)*(x^x*(log(x)+1)^2*log(x)+x^x/x*log(x)+2*x^x*(log(x)+1)/x-x^x/x^2)*log(x)+2*x^(x^x)*(x^x*(log(x)+1)*log(x)+x^x/x)/x-x^(x^x)/x^2)+x^(x^(x^x))*(x^(x^x)*(x^x*(log(x)+1)*log(x)+x^x/x)^3*log(x)+3*x^(x^x)*(x^x*(log(x)+1)*log(x)+x^x/x)*log(x)*(x^x*(log(x)+1)^2*log(x)+x^x/x*log(x)+2*x^x*(log(x)+1)/x-x^x/x^2)+3*x^(x^x)*(x^x*(log(x)+1)*log(x)+x^x/x)^2/x+x^(x^x)*(x^x*(log(x)+1)^3*log(x)+3*x^x*(log(x)+1)*log(x)/x+3*x^x*(log(x)+1)^2/x-x^x/x^2*log(x)+3*x^x/x^2-3*x^x*(log(x)+1)/x^2+2*x^x/x^3)*log(x)+3*x^(x^x)*(x^x*(log(x)+1)^2*log(x)+x^x/x*log(x)+2*x^x*(log(x)+1)/x-x^x/x^2)/x-3*x^(x^x)*(x^x*(log(x)+1)*log(x)+x^x/x)/x^2+2*x^(x^x)/x^3)
```

(3) LaTeX 命令 1 (原始程序):

```
{x}^{\left\{ {x}^{\left\{ {x}^{\left\{ {x} \right\}} \right\}} \right\} \left( {x}^{\left\{ {x}^{\left\{ {x} \right\}} \right\}} \left( {x}^{\left\{ {x} \right\}} \left( \ln \left( x \right) +1 \right) \ln \left( x \right) +\frac {\left\{ {x}^{\left\{ {x} \right\}} \right\} {x}}{\left( x \right)} \right) \ln \left( x \right) +\frac {\left\{ {x}^{\left\{ {x}^{\left\{ {x} \right\}} \right\}} {x}}{\left( x \right)} \right) ^{3}+3\, \left\{ {x}^{\left\{ {x}^{\left\{ {x}^{\left\{ {x} \right\}} \right\}} \right\}} \right\} \left( {x}^{\left\{ {x}^{\left\{ {x} \right\}} \right\}} \left( {x}^{\left\{ {x} \right\}} \left( \ln \left( x \right) +1 \right) \ln \left( x \right) +\frac {\left\{ {x}^{\left\{ {x} \right\}} \right\} {x}}{\left( x \right)} \right) \ln \left( x \right) +\frac {\left\{ {x}^{\left\{ {x}^{\left\{ {x} \right\}} \right\}} {x}}{\left( x \right)} \right) \left( {x}^{\left\{ {x}^{\left\{ {x} \right\}} \right\}} \left( {x}^{\left\{ {x} \right\}} \left( \ln \left( x \right) +1 \right) \ln \left( x \right) +\frac {\left\{ {x}^{\left\{ {x} \right\}} \right\} {x}}{\left( x \right)} \right) \ln \left( x \right) +\frac {\left\{ {x}^{\left\{ {x}^{\left\{ {x} \right\}} \right\}} {x}}{\left( x \right)} \right)
```







$$\begin{aligned}
& x^{x^{x^x}} \left( x^{x^x} \left( x^x (\ln(x) + 1) \ln(x) + \frac{x^x}{x} \right) \ln(x) + \frac{x^{x^x}}{x} \right)^3 + \\
& 3 x^{x^{x^x}} \left( x^{x^x} \left( x^x (\ln(x) + 1) \ln(x) + \frac{x^x}{x} \right) \ln(x) + \frac{x^{x^x}}{x} \right) \\
& \left( x^{x^x} \left( x^x (\ln(x) + 1) \ln(x) + \frac{x^x}{x} \right)^2 \ln(x) + x^{x^x} \left( x^x (\ln(x) + 1)^2 \ln(x) + \frac{x^x \ln(x)}{x} + \right. \right. \\
& \left. \left. 2 \frac{x^x (\ln(x) + 1)}{x} - \frac{x^x}{x^2} \right) \ln(x) + 2 x^{x^x} \left( x^x (\ln(x) + 1) \ln(x) + \frac{x^x}{x} \right) x^{-1} - \frac{x^{x^x}}{x^2} \right) \\
& + x^{x^{x^x}} \left( x^{x^x} \left( x^x (\ln(x) + 1) \ln(x) + \frac{x^x}{x} \right)^3 \ln(x) + 3 x^{x^x} \left( x^x (\ln(x) + 1) \ln(x) + \frac{x^x}{x} \right) \right. \\
& \left. \ln(x) \left( x^x (\ln(x) + 1)^2 \ln(x) + \frac{x^x \ln(x)}{x} + 2 \frac{x^x (\ln(x) + 1)}{x} - \frac{x^x}{x^2} \right) \right. \\
& \left. + 3 x^{x^x} \left( x^x (\ln(x) + 1) \ln(x) + \frac{x^x}{x} \right)^2 x^{-1} + x^{x^x} \left( x^x (\ln(x) + 1)^3 \ln(x) + 3 \frac{x^x (\ln(x) + 1) \ln(x)}{x} \right. \right. \\
& \left. \left. + 3 \frac{x^x (\ln(x) + 1)^2}{x} - \frac{x^x \ln(x)}{x^2} + 3 \frac{x^x}{x^2} - 3 \frac{x^x (\ln(x) + 1)}{x^2} + 2 \frac{x^x}{x^3} \right) \right. \\
& \left. \ln(x) + 3 x^{x^x} \left( x^x (\ln(x) + 1)^2 \ln(x) + \frac{x^x \ln(x)}{x} + 2 \frac{x^x (\ln(x) + 1)}{x} - \frac{x^x}{x^2} \right) x^{-1} - \right. \\
& \left. 3 x^{x^x} \left( x^x (\ln(x) + 1) \ln(x) + \frac{x^x}{x} \right) x^{-2} + 2 \frac{x^{x^x}}{x^3} \right)
\end{aligned}$$

### 三、练习

分别用 Mathematica 与 Matlab 求解下列数学问题，并给出结果的 LaTeX 源程序和相应的 PDF 文件；

1. 已知函数  $f(x) = \tan^2(x)$ ，求  $f''(x)$ ；
2. 已知函数  $g(x) = \tan(x)^{\cot(x)}$ ，求  $g''(x)$ ；
3. 已知函数  $h(x) = \frac{\tan(x)^{\cot(x)}}{\sin(x)^{\cos(x)}}$ ，求  $h^{(5)}(x)$ ；
4. 已知函数  $l(x, y) = \frac{\tan(x)^{\cot(y)}}{\sin(x)^{\cos(y)}}$ ，求  $\frac{\partial^5 l(x, y)}{\partial x^2 \partial y^3}$ 。